CONCERNING THE TRIASSIC IN THE YUGOSLAVIAN INNER DINARIDS (SOUTHERN SERBIA, EASTERN MONTENEGRO): MICROFACIES, MICROFAUNAS, AN ATTEMPT TO GIVE A PALEOGEOGRAPHIC RECONSTITUTION

von

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SUMMARY

Triassic formations are widely represented in the inner parts of the Yugoslavian Dinarids (from NE to SW, Vardar zone, Golija zone, upper Serbian zone including the Lim and Durmitor zones).

The study of microfacies and microfaunas enabled us to define the Stratigraphy and to consider a reconstitution of the Triassic paleogeography.

The Yugoslavian inner Dinarids are separated from the Carpathian arc by the Neogene basin of the Morava and the Serbo-Macedonian crystalline basement. They are hidden by the Pannonian basin in the North. They overthrust, in the SW, the outer Dinarids by the tangential disturbance of the Durmitor. Their originality comes, for one thing, from the development of ophiolitserie in the upper Jurassic, from a large and varied magmatism (of the Triassic down to Quaternary), from the succession of severals orogenic phases among which there are some early ones (lower Cretaceous).

At the height of southern Serbia and eastern Montenegro, the recent regional and structural studies (J. P. RAMPNOUX, 1970-1971) have enabled one to differentiate several structural unities, stretching NW-SW, equal to isopic zones because of their stratigraphic evolution during the alpine cycle.

They are from NE to SW: (fig. nº I)

- the Vardar zone (F. KOSSMAT 1924),
- the Golija zone, equivalent of the Pelagonian zone of the Hellenids,
- the „upper" Serbian zone (J. AUBOUIN, R. BLANCHET, J. P. CADET, P. CELET, J. CHARVET, J. CHOROWICZ, M. COUSIN, J. P. RAMPNOUX, 1971) which, in the studied region, may be differentiated into:

  the Lim zone including: the Zlatar subzone,
  the Mihajlovići subzone,
  the Čeotina subzone,

  the Durmitor zone.

This „upper" Serbian zone appears as equivalent to the subpelagonian zone and overthrusts the Bosnian zone already belonging to the outer Dinarids.

In these different zones, the Triassic formations are widely represented and the study of the microfaunas and microfacies (S. Pantić, 1965, 1966, 1967, 1969, 1970) has enabled one to determine precisely their stratigraphy and to look at a paleogeographic reconstitution available for the region stretching between the Zlatiborn massive and the upper valley of the Drina in the North and the border of the Kosovo in the South.

STRATIGRAPHIC DESCRIPTION: MICROFACIES AND MICROFAUNAS

The alpine cycle begins in the studied region with the permo-Werfenian transgression characterized by the deposit of conglomerates, sandstones and red pelites, mixed, near the lower part, with some layers of gypsum and bedded limestones, sometimes bituminous, with microfaunas of the upper Permian; this formation holds faunas of the Werfenian (see below) near the upper part. This detrital Permo-Werfenian lies mostly (J. P. RAMPNOUX, 1968) without any appreciable discordance, but with a patent stratigraphical lacuna, on the Paleozoic with the facies „Culm" (schists, sandstones, and brecciated limestones) of the middle Carboniferous.

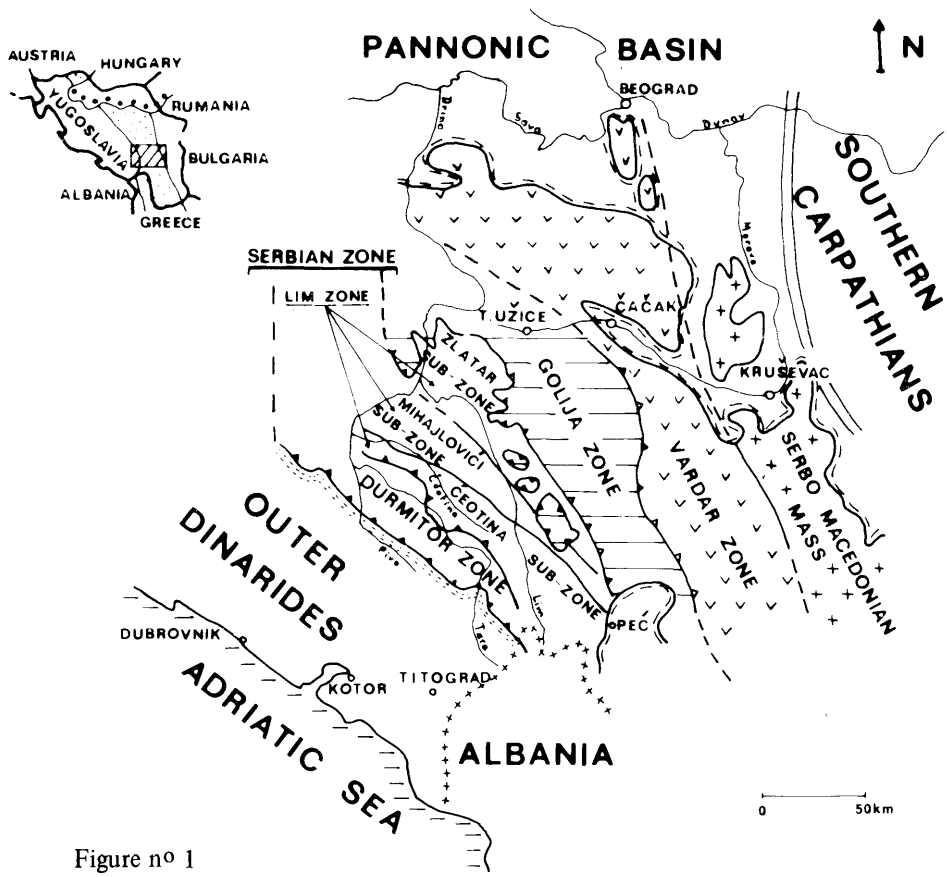

Figure nº 1

-- Map of the inner Dinarids in Serbia and Montenegro (Yougoslavia)

The lower Triassic. It crops out in all the zones with the exception of the eastern part of the Vardar zone. It is represented from the lower part to the upper one:

1) by red detrital facies, as formely described, containing the association: *Claraia clarai* EMM, *Claraia aurita* HAUER;

2) here and there by oolitic limestones partly dolomitized. The microfacies is that of a dolomitic oosparite with: *Meandrospira iulia* (PREMOLI SILVA) *Glomospira sp., Ammodiscus incertus* (D'ORB);

3) by neritic dolomitic limestones in small layers with numerous worms' tubulures and with: *Myophoria costata* ZENK, *Naticella costata* MUNSTER, *Turbo rectocostatus* HAUBER, *Tirolites cassianus* QUENTS.

The microfacies is, mostly, a dolomitic biosparite with Molluscs' section containing: *Meandrospira iulia* (PREMOLI SILVA), *Ammodiscus incertus* (D'ORB), *Glomospira* cf. *sinensis* HO.

Note: + In the Permo-Werfenian or the pure Werfenian, interstratified brecciated limestones reworking elements of limestones with bashkirian microfaunas are found locally (J.P. RAMPNOUX, 1968).

+ Moreover, in the Golija zone, some flows of paleoandesites, very much weathered, appear in the upper Werfenian.

The Middle Trias

THE ANISIAN: It offerts a large homogenity in its facies and its microfauna. One may differentiate from the lower part to the upper one:

1) massive limestones, sometimes dolomitic, with traces of Algae, Gasteropods and Brachiopods.

The microfacies generally is an intrabiosparudite or an biosparite with some pelsparitic flows having a rich microfauna containing, specially, Foraminifers: *Meandrospira dinarica* KOCH. DEV and PANTIĆ, *Glomospira densa* (PANTIĆ), *Glomospira sygmoidalis* (RAUSER), *Glomospira gordialis* (JONES and PARKER), *Glomospira sinensis* HO, *Glomospira articulosa* PLUMMER, *Glomospirella irregularis* (MOELLER), *Glomospirella grandis* SALAJ, *Glomospirella ammodiscoides* (RAUSER), *Glomospira triphonensis* ZANINETTI, *Duostomina alta* KRISTAN-TOLLMANN, *Earlandia tintinniformis* MIŠIK, *Trochammina alpina* KRIST-TOLLMANN, *Trochammina jaunensis* BRÖNNIMANN and PAGE, *Trochammina almtalensis* KOEHN-ZANINETTI, *Neoendothyra reicheli* REITLINGER, *Earlandinita elongata* SALAJ, *Earlandinita oberhauseri* SALAJ, *Endothyranella wirzi* (KOEHN-ZANINETTI), *Endothyranella pentacamerata* SALAJ, *Endothyranella bicaremata* SALAJ, *Frondicularia woodwardi* HOWCH, *Turritellella mesotriassica* KOEHN-ZANINETTI, *Diplotremina austrofimbriata* KRISTAN-TOLLMANN and Algae: Cyanophyta, Codiacea and Dasycladacea: *Macroporella alpina* PIA, *Physoporella pauciforata* (GÜMBEL) var *sulcata* BYSTR, *Diplopora cf hexaster* PIA, *Teutloporella sp.*

Moreover, in the Vardar zone, associations of Conodonts have been described (S. PANTIĆ, 1969): *Gondolella navicula* HUCKRIEDE, *Gondolella mombergensis* TATGE, *Lonchodina venusta* HUCKRIEDE, *Lonchodina spengleri* HUCKRIEDE, *Prioniodella ctenoides* TATGE.

2) Limestones with „Han bulog" facies (Bulogerkalke, E. KITTL, 1904) rich in faunas of Ammonites. These Ammonites are reworked and generally there are mixed faunas of middle and upper Anisian.

They appear:

- either as massive limestone, the elements of which offer the same microfacies and the same microfauna as seen before, run through by a network of fissures filled with a reddish cement in which the beds of Ammonites are localized. This cement is generally made up of a sitous, ferruginous micrite with Radiolarias, Sponges' spiculae, pelagian Molluscs' and Echinoderms' fragments. It makes one think of a submarine karst filled up by currents;
- or, as red nodulous condensed limestones with a facies „ammonitico rossi" in which the Cephalopods are wrapped up in a ferric or manganic crust. The microfacies is a biomicrite with Radiolarias, Sponges' spiculae, Ostracods, Echinoderms' fragments, pelagian Lamellibranchiates' and Cephalopods' sections. Now and then, thin „bio-

sparitic" flows show the association: *Meandrospira dinarica* KOCH-DEVID and PANTIĆ, *Glomospira densa* (PANTIĆ), *Macroporella alpina* PIA.

These limestones „Han bulog" of the middle or upper Anisian are contemporary with the volcanic episode of the Porphyrites.

This submarine activity is characterized:

- either by the setting of cupola (region of Babine in the subzone of Mihajlovići, region of Ljubišnja in the zone of the of the Durmitor) passing through the lower and middle Anisian and, directly or through the medium of a conglomerate, covered up by the upper Anisian with „ammonitico rosso" facies;
- or by small lava flows or, more often, by green-coloured volcanic tuffs associated with radiolarites and fine graywackes.

This formation called „Porphyrit Hornstein Formation" by B. ĆIRIĆ (1954) generally overtops the „ammonitico rosso" facies but sometimes may alternate with these; in this last case, the limestones become richer in siliceous kidneys and their microfaunas becomes richer in Radiolarias.

THE LADINIAN: From the Ladinian, the facies are more varied.

1) **The Ladinian in the Golija zone, Mihajlovići subzone, and in the Durmitor zone**(1)

It is represented by nericitic or reef massive limestones with Sponges, Hydrozoas, Madrepores, Bryozoas, Molluscs, Brachiopods.

The most widely spread microfacies is that of a biosparite with:

- Algae: Cyanophyta, Dasycladaceae: *Diplopora annulata* SCHAFHÄULT, *Teutloporella herculea* (STOPPANI), *Teutloporella nodosa* (SCHAFHÄULT); *Codiaceae: Baccanella floriformis* PANTIĆ; Solenoporaceae.
- Foraminifers: *Vidalina martana* FARINACCI, *Neoendothyra sp.*, Ophtalmidium sp., Variostoma sp., Lituolidae.
- Sponges: *Cryptocoelia zitelli* OTT, *Colospongia catelunata* OTT, *Ladinella porata* KRAUS and OTT.
- Coelenteratas.

Sometimes, in the reef bioherms, the microfacies is a biolithite with Algae and Coelenteratas.

N. B.: Occasionally the Ladinian, when it directly overtops the porphyritic tuffs, begins with a few yards of bedded cherty limestones (biomicrite with Radiolarias) but, soon, the neritic sedimentation prevails.

2) **The Ladinian of the Zlatar and Ćeotina subzones**

It is characterized by fine pelagic bedded cherty limestones, with some beds of jaspers alternating with marly joints.

The microfacies is a biomicrite with Radiolarias, Spongeś spiculae, Echinodermś fragments, pelagic Lamellibranchiateś sections. The Foraminifers are scarce, let us mention: *Vidalina martana* FARINACCI, *Frondicularia sp.*

Here and there, in contact with the Golija and Mihajlovići zones, series of transition are noticed: in them the pelagic limestones get interstratified with breccian beds

(1) - In the studied region of the Vardar zone, a surface of truncation, anterior to the upper Jurassic, excises part of the postanisian formations.

reworking the neritic limestones (Intrasparrudites with intraclasts with Algae and Coelenteratas).

Moreover, in the Ćeotina subzone, neritic and reef recurrences appear among the pelagic formations.

The upper Triassic. As the Ladinian, two large types of facies are to be opposed: the neritic ones of the Golija, Mihajlovići and Durmitor zones, and the pelagic ones of the Zlatar and Ćeotina subzones.

1) The upper Triassic in the zones of Golija, Mihajlovići and of the Durmitor

THE CARNIAN: It is most often characterized by neritic or reef limestones with facies and microfacies much like those of the Ladinian. We may notice the presence, near the Coelenteratas and Sponges, the view of the first Megalondontes. The most often found facies is a biosparite containing, here and there, Algae, among which: *Clypeina besici* PANTIĆ, *Poikiloporella duplicata* PIA, *Physoporella heraki* nv. sp., *Foraminifers: Trocholina multispira* OBERH, *Trocholina biconvexa* OBERH, *Glomospirella sp., Involutina sp.*

N. B.: Locally, in the Golija zone, the Carnian appears under an original facies, recalling the „Han bulog" facies, composed of grey breccian limestones with red cement (fine micrite) containing besides Algae as *Clypeina besici* PANTIĆ, a rich fauna of Ammonites wrapped up by manganese and iron (E. BASSE DE MENORVAL and J. P. RAMPNOUX, 1968).

THE NORIAN: It is mostly composed of grey neritic limestones in which the Megalodontes are close to the Coelenteratas, the Sponges and the Bryozoas.

For the most part, the facies is a biosparite with: *Involutina sinuosa* (WEYNSCHENK), *Involutina communis* (KRISTAN), *Involutina sinuosa pragsoides* (OBERHAUSER), *Trocholina permodiscus* OBERHAUSER, *Galeanella tollmani* (KRISTAN), associated with Algae: Cyanophyta, Codiacea, Dasycladaceae: *Gryphoporella curvata* (GUMB) PIA, *Thaumatoporella parvovesiculifera* (RAIN).

In some places, the Norian is represented by finer limestones, better stratified, containing nothing but Megalodontes. Their microfacies is a micrite containing a scanty fauna with: *Turrispirillina minima* PANTIĆ, *Vidalina martana* FARINACCI.

Sometimes this micrite becomes a typical dismicrite.

THE RHETIAN: It shows the same facies and microfacies as the Norian. Yet, the limestones are better stratified, one may find, in the biosparitic layers, these Foraminifers: *Involutina pragsoides oscilens* (OBERHAUSER), *Triasina hantkeni* MAJZON, *Galeanella tollmanni* (KRISTAN), associated with fragments of Algae, Ostracods and Echinoderms.

2) The upper Triassic in the Zlatar and Ćeotina subzones

It is represented, as is the underlaying Ladinian, by fine pelagic limestones with cherty nodules and nodular jaspers becoming richer with marly beds near the top. This formation passes insensibly to the Lias which is characterized by the same facies but in which the beds of marls and pelites become more important. The faunas are scanty and not very typical, we may mention a few fragments of Halobia and Daonella.

The microfacies is that of a micrite or biomicrite with Radiolaries, Sponges spiculae, pelagic Molluscs sections. The Foraminifers are scanty: *Nodosaria sp., Frondicularia sp., Ammodiscus sp.* The chronology of these layers is not defined precisely, it is inferred from the underlaying Ladinian and the overlying Lias.

As for the Ladinian, in the Zlatar subzone, in contact with the Golija zone, and in the Ćeotina subzone, in contact with the Mihajlovići subzone, a transition series exists in which the pelagic cherty limestones may be interstratified with breccian limestones reworking the synchronous neritic deposits.

CONCLUSIONS

Main stratigraphical characteristics

From the above study, some facts may be noted:

The mesozoic cycle begins with the permo-werfenian transgression, characterized by red detrital sea formations.

The Anisian is the most homogeneous in the whole of the inner Dinarids. After the episode of the neritic limestones from the lower Anisian to the middle one, the upper Anisian is characterized by the association of limestones with „Han bulog" facies (Bulogerkalke) and of submarine volcanic manifestations: the „Porphyrites". These latter may lead to modifications of microfacies, with the development of biomicrites with Radiolarias, radiolarites and of graywackes, which consequently have no bathymetric meaning.

From the Ladinian and through out the whole upper Triassic, one may note marked differentation of the facies:

neritic of reef limestones in the zones of Golija, Mihajlovići, Durmitor characterized by microfacies with a biosparitic predominance, rich in Algae, Coelenteratas, benthonic Foraminifers, fragments of hard-shelled Molluscs;

pelagic limestones with chert of jaspers, not thick and yet not „condensed" in the subzones of Zlatar and Ćeotina characterized by microfacies with a micritic to a biomicritic predominance, with a decreasing microfauna: Radiolarias, Sponges' spiculae, scanty Foraminifers, filaments of pelagic Lammellibranchiates. These facies, rather like those of „Hallstatt", appear to us as characterizing zones deeper than the preceding ones.

This bathymetric hypothesis chiefly based on the microfacies and the microfaunas seems to be sustained by the presence of breccian layers with neritic and reef components, interstratified in the pelagic facies of the zones of transition to the neritic zones. However, the bathymetry must not have been excessive as, on the one hand, there are no layers of clear radiolarites bound to huge depths as in the large furrow (Pindus type J. AUBOUIN, 1959), (the siliceous sedimentation is limited to the laying of chert, or even, of beds of jasper nodules always associated with limestones) and, on the other hand, neritic or reef intercalations appear here and there in the Ćeotina subzone.

A Paleogeographical sketch (fig. n° 2)

In the Permo-Werfenian and in the Anisian, the inner Dinarids, with the exception of the inner emerged zone of the Vardar, corresponded to a large platform on which, after

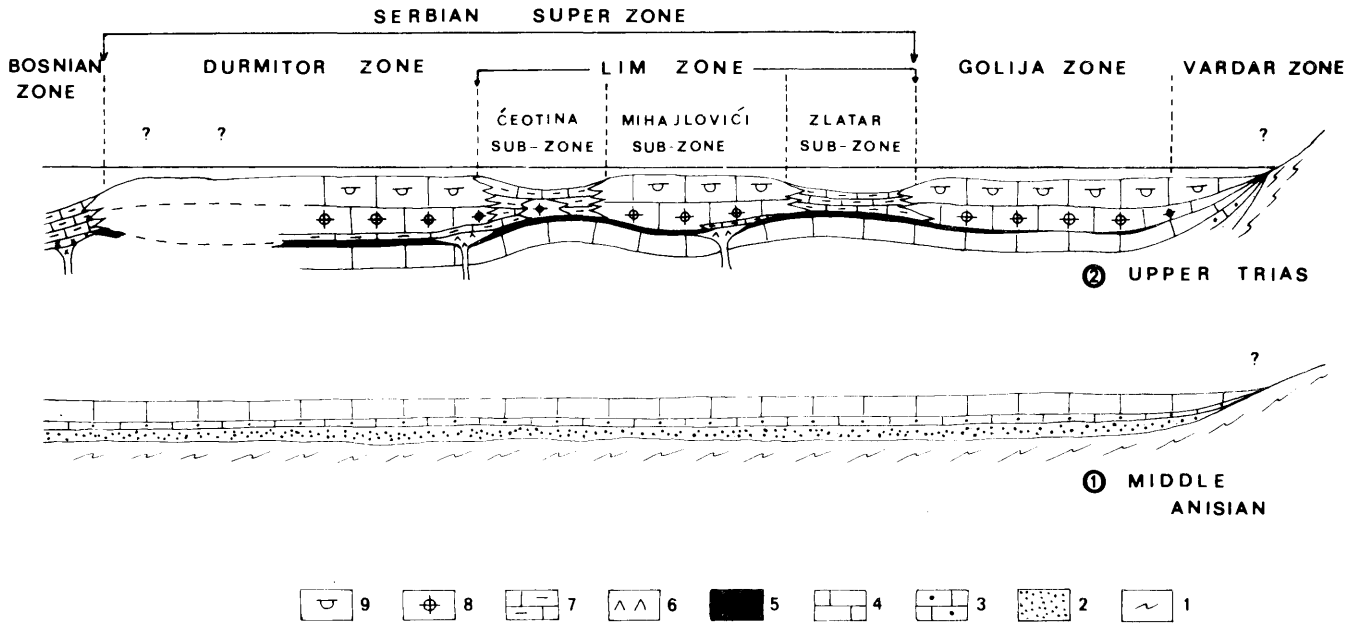

Figure nº 2

– Paleogeographical reconstitution of Triassic in the inner Dinarids.

1 – Paleozoic basement
2 – Conglomerates, sandstones and pelites of the Permo-Werfenian
2 – Limestones of the upper Werfenian
4 – Neritic limestones of the under and middle Anisian
5 – Porphyrite tuffs and associated „Han bulog" faciès of the upper Anisisan
6 – Massive porphyrites
7 – Cherty pelagic limestones of the Ladinian and upper Triassic
8 – Neritic or reef limestones of the Ladinian
9 – Neritic or reef limestones of the upper Triassic

the detrital layers of the Permo-Werfenian, a calcareous neritic sedimentation was deposited.

In the upper Anisian, a porphyritic volcanism, rich in tuffmade elements, is contemporary, either with submarine paleokarsts, in which Cephalopods' shells, cemented with a ferruginous matrix, are gathered, or with „condensed" facies „ammonitico rosso".

In the Ladinian and throughout the upper Triassic, a series of neritic or reef ridges got individualized and settled. They were separated by depressed zones with a pelagic sedimentation, marked, here and there, by the appearing of flank breccias descended from ridges.

Thus may be differentiated from NE to SW and axially stretching from NW to SE:

- an eastern platform corresponding to the Golija-zone to western part of the Vardar zone;
- the depressed zone of the Zlatar;
- the narrow ridge of Mihajlovići;
- the depressed zone of Ćeotina;
- the ridge of the Durmitor. The latter skirts the NE border of the Bosnian furrow.

These isopic zones kept their individuality throughout the whole Jurassic.

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PLATE I

WERFENIAN

Fig. 1 – Oolitic limestones with *Ammodiscus incertus* D'ORB
Thin slide nº JPR D 624 (X 30)
Locality: Bukovica valley (Durmitor zone)

Fig. 2 – Dolomitized limestones with *Meandrospira iulia* (PREMOLI SILVA).
Thin slide JPR nº 121 (X 30).
Locality: south of Košťam-Polje (Zlatar subzone).

ANISIAN

Fig. 3 – Intrabiosparite, feebly dolomitized with *Glomospira densa* (PANTIĆ), *Cyanophyta* Echinoderms.
Thin slide JPR nº A 940' (X 15).
Locality: Rudnica (Mihajlovići subzone).

Fig. 4 – Intrabiosparite, feebly dolomitized with *Glomospira irregularis* (MOELLER), Echinoderms', Molluscs' fragments.
Thin slide JPR D 716 (X 25).
Locality: Trpezi (East of Ivangrad) (Ćeotina subzone).

Fig. 5 – Marbled limestones with *Turritellella mesotriassica* KOEHN-ZANINETTI and *Cyanophyta*.
Thin slide JPR nº 814.
Locality: Šaronje (south of Košťam Polje) (Ćeotina subzone).

Fig. 6 – Intrabiosparite, feebly dolomitized with *Diplotremina austrofimbriata* KRISTAN-TOLLMANN and *Cyanophyta*
Thin slide JPR B 594.
Locality: Odzak (Mihajlovići subzone).

Fig. 7 – Dolomitized limestone with Radiolarias and pelagic Lamellibranchiates.
Thin slide JPR B 9 (X 30).
Locality: Road from Pljevlja to Gradac (Ćeotina subzone).

Fig. 8 – Intrabiosparite with *Earlandia elongata* SALAJ, Cynanophyta and Echinoderms fragments.
Thin slide JPR B 5.
Locality: Road from Pljevlja to Gradac (Ćeotina subzone).

PLATE II

ANISIAN

Fig. 1 – *Meandrospira dinarica* KOCH DEVID and PANTIĆ.
Thin slide JPR D 246 (X 23).
Locality: Jadovnik (Golija zone)

LADINIAN

Fig. 2 – Dolomitized limestone with *Baccanella floriformis* PANTIĆ.
Thin slide JPR B 89 (X 30).
Locality: Road from Prijepolje to Pljevlja (Mihajlovići subzone).

Fig. 3 – Intrabiosparudite with *Diplopora annulata* SCHAFHÄULT.
Thin slide JPR B 168 (X 25).
Locality: Ljubišnja (Durmitor zone).

CARNIAN

Fig. 4 – Breccian limestone with *Clypeina bešići* PANTIĆ and Ostracods.
Thin slide JPR 806 (X 30).
Locality: Koštam Polje (Golija zone).

Fig. 5 and 6 Intrabiosparudite dolomitized with *Poikiloporella duplicata* PIA.
Thin slide JPR B 80 (X 25).
Locality: Popov Do (Ljibišnja) (Durmitor zone).

PLATE III

NORIAN

Fig. 1 – Micrite with *Turrispirillina minima* PANTIĆ.
Thin slide J. P. R. D 521 (X 50).
Locality: Southern Sinjajevina (Durmitor zone).

Fig. 2 – Intrabiosparite with *Trocholina permodiscoidea* OBERHAUSER, Cyanophyta.
Thin slide JPR D 669 (X 30).
Locality: Trsa (Durmitor zone).

Fig. 3 – Intrabiosparite with *Involutina sinuosa sinuosa* WEYSCHENK) and algolithe structure.
Thin slide JPR D 599 (X 30).
Locality: Ranisava (Durmitor zone).

Fig. 4 – Intrabiosparite with *Involutina communis* (KRISTAN).
Thin slide JPR D 599 (X 30).
Locality: Ranisava (Durmitor zone).

Fig. 5 – Intrabiosparite with *Duosotminidae, Involutina sp.*, Cyanophyta.
Thin slide JPR D 652 (X 30).
Locality: Mihajlovići (Mihajlovići subzone).

Fig. 6 – *Galeanella tollmanni* (KRISTAN)
Thin slide JPR A 981 (X 30).
Locality: Mataruge (Mihajlovići subzone).

Plate I

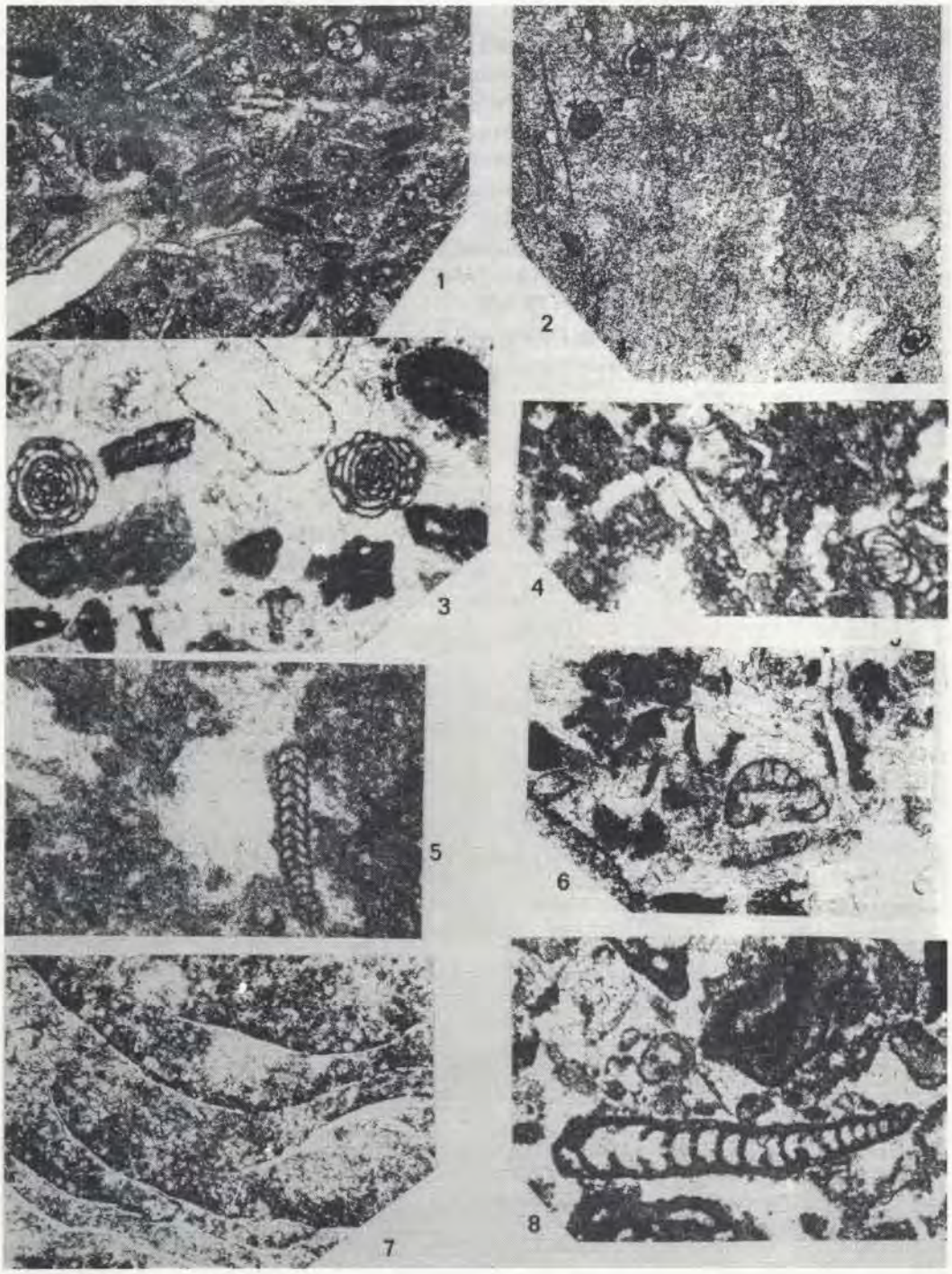


Plate II

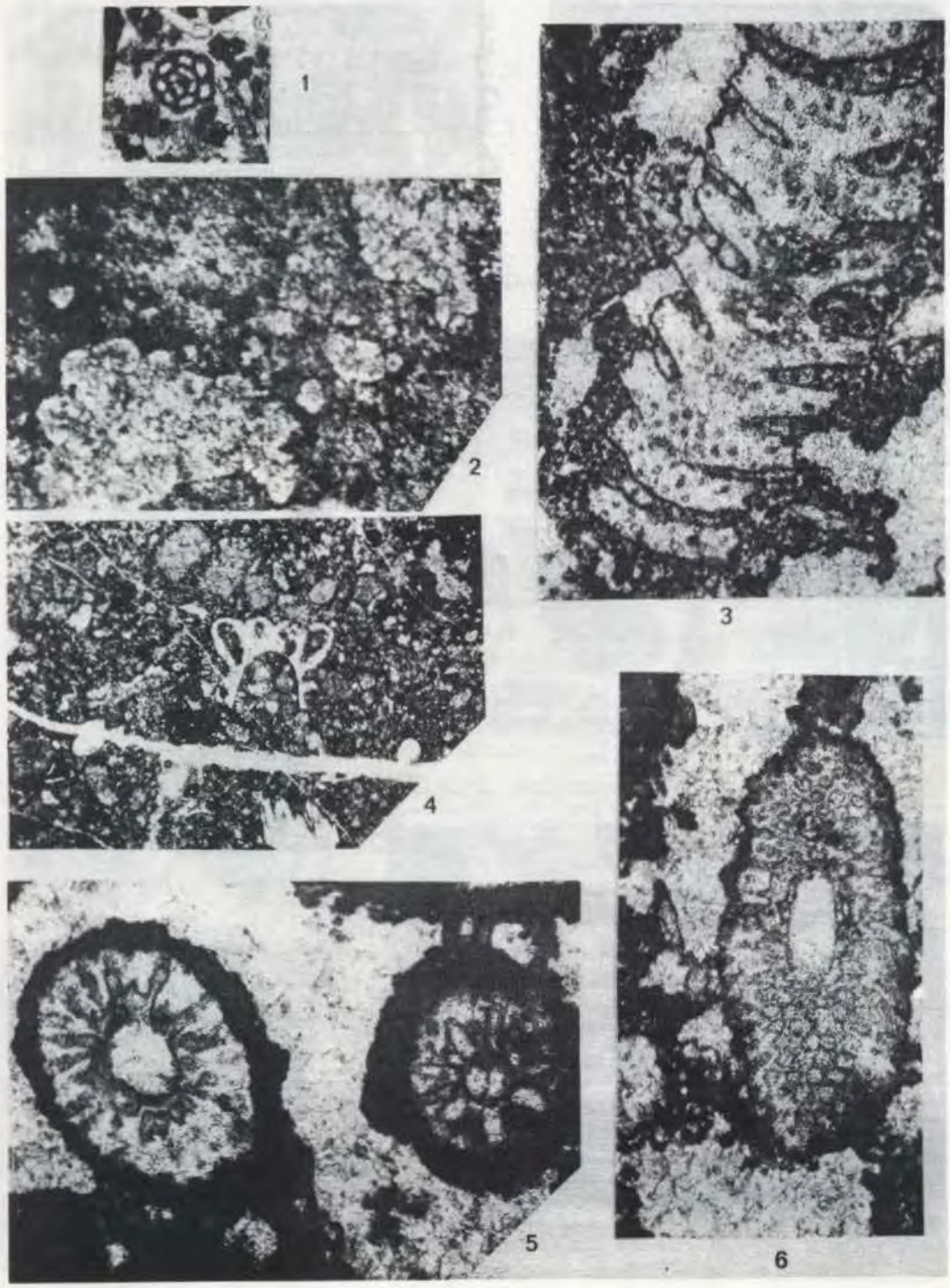
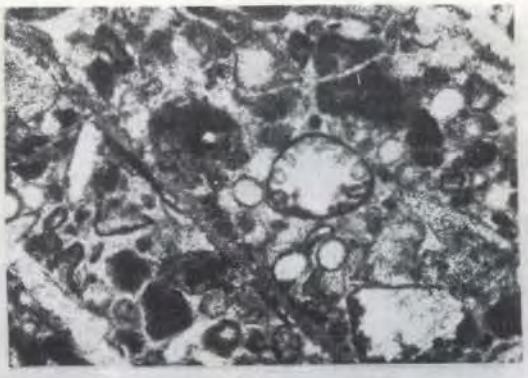
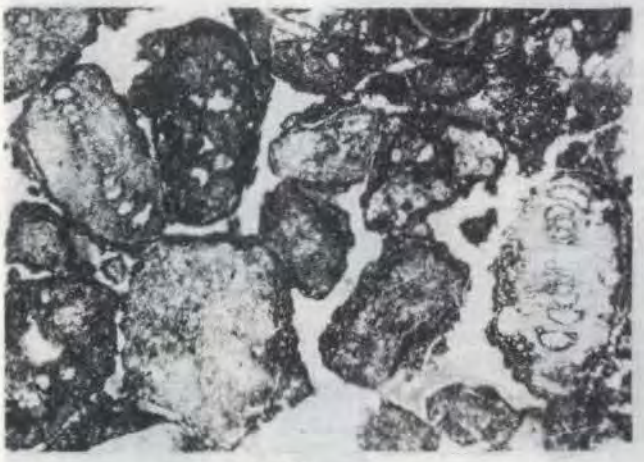


Plate III

1

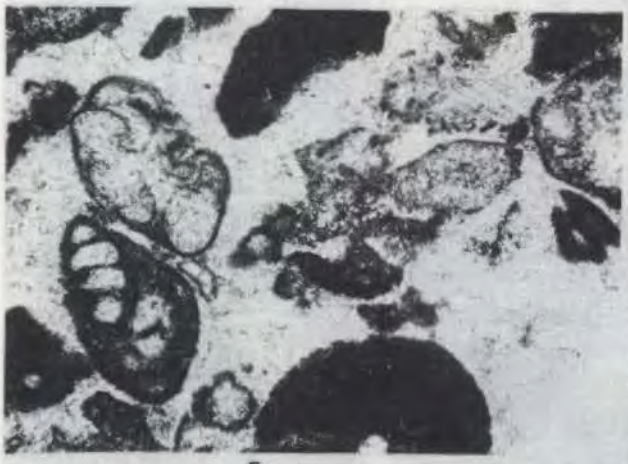


2

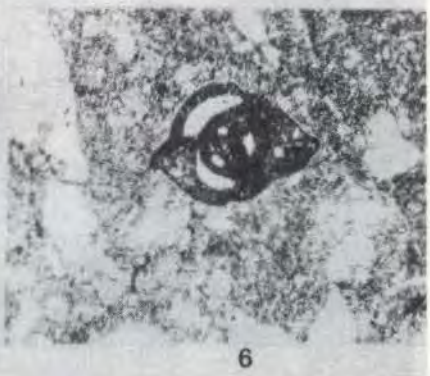


3

4



5



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